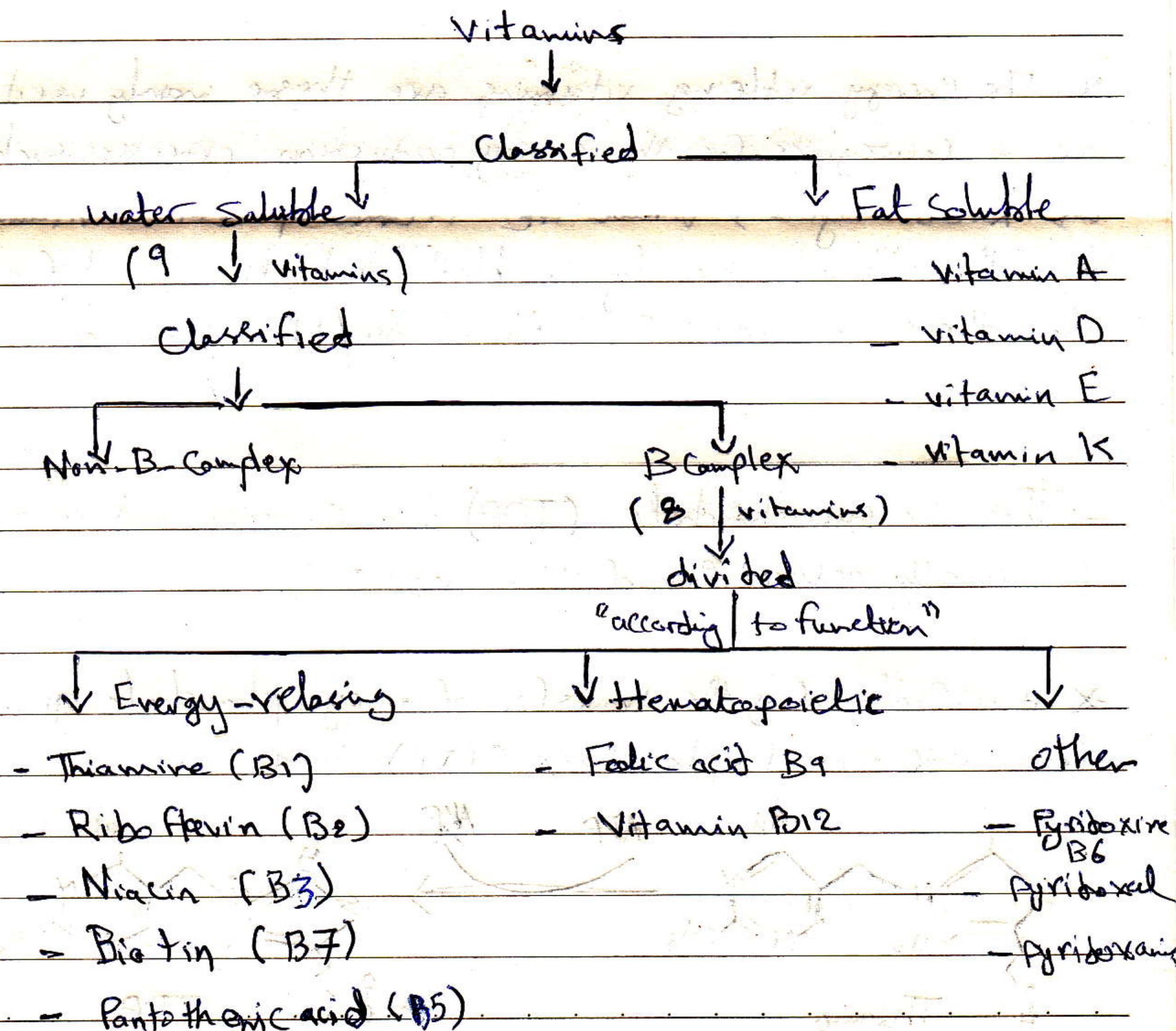
Coenzymes and Vitamins

Vitamin B_1 (thiamine)

Components: Composed of two (thiazole ring + substituted Pyrimidine ring)

Coenzymes and vitamins (review)

* Vitamins: are organic compounds required by the body in trace amounts to preform specific cellular functions.



* Vitamins: our body is unable to synthesize them or synthesize them in insufficient amounts

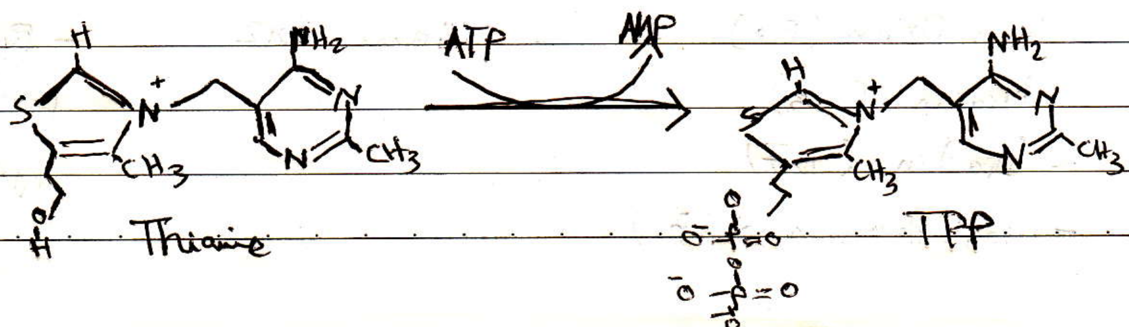
* all water soluble vitamins are Coenzymes either directly or indirectly, but for the fat soluble vitamins Vitamin K is the only one that function as a Coenzyme.

* Fat soluble vitamins are toxic if taken in large amounts and vitamins A, D are the most toxic where vitamin E is the least toxic.

* The energy releasing vitamins are those mainly used as a Coenzymes for the energy production processes such as Krebs cycle, while the Hematopoietic vitamins are those used mainly in blood production, and for the others are used for both energy/blood production processes.

- Thiamine pyrophosphate (TPP): a Coenzyme, and is the biologically active form of Thiamine (B1)

* it is formed by the transfer of a pyrophosphate group from adenosine triphosphate (ATP) to thiamine



* it Consists of two rings Thiazole ring, and substituted pyrimidine ring and two phosphate groups, the two rings are linked by a methyl bridge.

- Clinical indications for thiamine

The activity of the oxidative decarboxylation of pyruvate and α-Ketoglutarate is decreased ((the two dehydrogenase-catalyzed reaction is decreased)) resulting in a decrease in ATP production (when thiamine is absent)

- thiamine-deficiency diseases;

1- Beriberi :- Severe Thiamine-deficiency syndrome, adult deficiency is characterized by dry skin, irritability, disordered thinking, and progressive paralysis and in Infants the signs are :- thachycardia, Vomiting, Convulsions and if not treated it causes death.

2- Wernicke-Korsakoff syndrome: is a thiamine defficiency associated with chronic alcoholism, is due to dietary insufficiency or impaired intestinal absorption of the vitamin. it is characterized by :- apathy, loss of memory, ataxia and a rhythmic to-and-fro motion of the eye balls (nystagmus) it is treatable with supplementation of thiamine.

* Thiamine deficiency is diagnosed by an in-crease of transketolase activity observed on addition of TPP.

- Flavin-Coenzymes (FMN and FAD): Flavin mononucleotide (FMN) and Flavin adenine dinucleotide (FAD) are the two biologically active forms (Coenzymes) of riboflavin (B_2)

  - FMN = vit. B_2 + Phosphate group
  - FAD = FMN + AMP

* FMN and FAD are each capable of reversibly accepting two hydrogen atoms, forming $FMNH_2$ or $FADH_2$

* both are involved in oxidation-reduction reactions

* Riboflavin is considered as a nucleotide consisting of Nitrogen base (isoalloxazine ring) a Sugar (Ribitol = sugar alcohol) and a phosphate group

* Riboflavin deficiency is not associated with a Major human disease, although it frequently accompanies other vitamins deficiencies

* B_2 deficiency is characterized by dermatitis, cheilosis, and glossitis.

- Pyridine nucleotides (NAD^+ and $NADP^+$):

Nicotinamide adenine dinucleotide (NAD^+) is a biologically active coenzyme composed of two parts
1- Nicotinamide nucleotide 2- Adenine nucleotide (AMP)

* ($NADP^+$) Nicotinamide adenine dinucleotide phosphate is another biologically active coenzyme

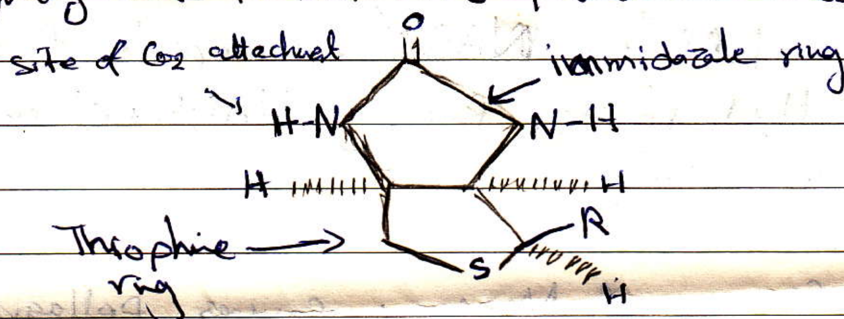
* both NAD^+ and $NADP^+$ are capable of accepting a H^- Hydride ion forming $NADH + H^+$ or $NADPH + H^+$ respectively.

* Deficiency of Niacin: causes pellagra, a disease involving the skin, gastrointestinal tract, and CNS, the symptoms of pellagra progress through the three Ds: dermatitis, diarrhea, dementia — and if not treated death

* As a treatment of hyperlipidemia:-
Niacin at high doses strongly inhibits lipolysis in adipose tissue, which results in lowering VLDL and LDL, there fore Niacin is particulary useful in the treatment of type IIb hyperlipoprotenemia.

* Biotin: (Vitamin H), is covalently bound to the ε-amino group of lysine residue of biotin dependent enzyme. The coenzyme form is called as biocytin. It's a coenzyme in carboxylation reactions, in which it serves as a carrier of activated carbon dioxide (CO_2)

* Raw egg white contains a glycoprotein called Avidin that tightly binds to biotin and prevents its absorption



Biotin B6

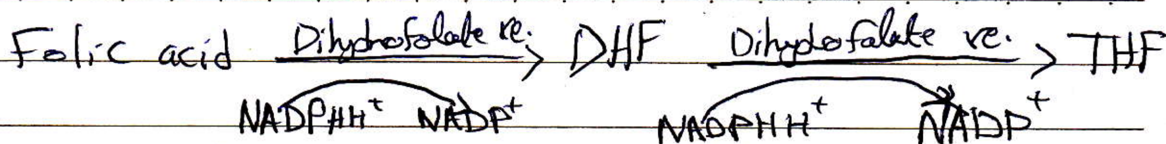
* B6 is usually found attached to valeric acid ($(CH_2)_4COOH$)

* Coenzyme A (CoA~SH):-

Coenzyme A is the biological active form of the vitamin pantothenic acid. It functions in the transfer of acyl groups. Coenzyme A contains a thiol (-SH) group that carries acyl compounds as activated thiol esters.

* Folic Acid B9 (Folate):-

Folic acid (or folate) is the vitamin. The biologically active (coenzyme) form of folic acid is tetrahydrofolic acid (THF), which is produced by the two-step reduction of folate by dihydrofolate reductase.



* NADPHH+ is needed as H donor for the reduction reaction.

* The one carbon unit or fragment is attached to folic acid at carbon 5

★ CoBalamin (B12)

Cobalamin contains a Corrin ring system, The Coenzyme forms of Cobalamine are 5' deoxyadenosylcobalamine and Methylcobalamine

Corrin rings = tetrapyrole

* Cobalamie is required in humans for two essential enzymatic reactions: The remethylation of homocysteine to methionine and the isomerization of methylmalonyl coenzyme A